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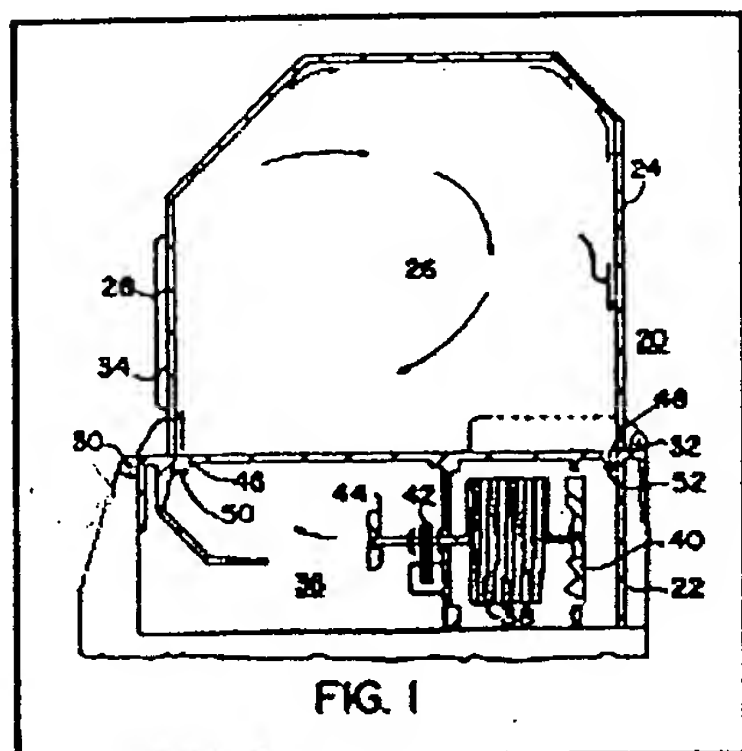


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33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

## Documento 28



Clasif.Principal A61G11/00

Título SISTEMA DE CONTROL DE TEMPERATURA EN UNA INCUBADORA DOBLE

Resumen INCUBADORA PARA RECIEN NACIDOS QUE TIENE UN SISTEMA CALEFACTOR (38) QUE PROPORCIONA UN FLUJO DE AIRE CALIENTE AL INTERIOR DEL COMPARTIMENTO DEL BEBE (26) Y QUE EXTRAHE EL AIRE DE DICHO COMPARTIMENTO. UN SENSOR DE TEMPERATURA (50) ESTA SITUADO EN LA ENTRADA DE AIRE (46) DEL AIRE CALIENTE AL COMPARTIMENTO DEL BEBE, Y OTRO SENSOR DE TEMPERATURA (52) ESTA SITUADO EN LA SALIDA DE AIRE (48) DEL AIRE PROCEDENTE DEL COMPARTIMENTO DEL BEBE. EL SISTEMA CONTROLA POR TANTO LA TEMPERATURA DEL AIRE QUE ACCEDE AL COMPARTIMENTO DEL BEBE Y DEL AIRE QUE SALE DE DICHO COMPARTIMENTO. ANALIZANDO LAS TEMPERATURAS DE LA ENTRADA Y SALIDA, EL SISTEMA CALEFACTOR DE LA INCUBADORA PUEDE CONTROLARSE Y SIN EMBARGO SE OBTIENE UNA VENTAJA ADICIONAL UTILIZANDO LA INFORMACION SOBRE TEMPERATURA PARA RECONOCER UN FALLO O DEFICIENCIA EN EL SISTEMA DE LA INCUBADORA.

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**"INFANT INCUBATOR"**

THIS INVENTION relates to an infant incubator. In particular, the invention provides an incubator for newborns which provides uniform heating and accurate  
5 temperature control.

**BACKGROUND ART**

It is common practice for premature babies and newborn infants with respiratory or other ailments to be placed in incubators. Such incubators provide a thermally controlled  
10 environment for the newborns which places minimal stress on the infant's thermoregulatory mechanisms.

The incubators normally comprise a chamber having a transparent cover, a heating mechanism, ventilation means, and a temperature control mechanism.  
15 The incubators are designed to control the air temperature within the chamber accurately, while allowing access for nursing care and other therapeutic or diagnostic methods.

Infant incubator design has provided two broad classes of devices; namely, open radiant heaters and  
20 closed chambers. Both types of devices consist of a platform or mattress on which the infant is placed and restrained to some degree. In radiant heaters, a heating source located above the infant is used to provide radiative warming of the infant. Examples of incubators  
25 with radiant heating can be found in U.S. patents nos. 5,119,467; 5,162,038 and 5,285,519.

In the closed chamber type, a closed transparent canopy covers the platform, and suitably warmed air is introduced from outside the canopy, or recycled from  
30 within the incubator. An example of a closed chamber incubator can be found in U.S. patent no. 4,321,913.

Although it is known to use transparent film radiant heat sources in incubators to provide distributed heating, radiant heating incubators still suffer from the  
35 disadvantage that the upper side of the infant receives far more heat than the lateral sides and underside of the infant. The heating provided by radiant heaters is

generally not as uniform as convection heating used in closed chamber incubators.

Closed chamber incubators, such as that described in U.S. patent no. 4,321,913, typically use a conventional heater to heat an airstream. The heater may be located under the platform on which the infant is placed. Known closed chamber incubators are relatively expensive.

It is an object of the present invention to provide an improved incubator of the closed chamber type.

#### SUMMARY OF THE INVENTION

In one broad form, this invention provides an incubator suitable for newborn infants and the like, comprising

- a base,
- a canopy over the base defining a chamber between the canopy and the base,
- a fan for producing an airflow into or around the chamber, and
- heating means for heating the airflow, characterised in that the heating means comprises a generally planar heating element.

Typically, a platform is provided on top of the base, on which an infant is laid.

In one embodiment of the invention, the heating element is located within the base, and under the platform. The fan blows air across the heating element and into the chamber. The heating element not only warms the air, but also warms the platform on which the infant rests. The distributed nature of the heating avoids "hot spots".

Further, the planar nature of the heating element allows it to be inserted in a horizontal orientation under the platform, thereby permitting the base to be of low compact design.

Advantageously, the incubator includes means for humidifying the air passing into the chamber. The

humidifying means comprises water placed in the airflow path and heated by the heating means. In the preferred embodiment, the water is fed by capillary action from a reservoir to an absorbent pad or sponge in contact with the face of the heating means. As the airflow passes over the heated water in the pad or sponge, it picks up warmed moisture. In this manner, warmed and humidified air is delivered to the chamber. Moreover, by incorporating the humidifying means with the heating means, an additional heating source for humidification is not required.

In a second embodiment, the canopy has a double wall, and the planar or membrane heating element is located between the twin walls of the canopy. Air is blown by the fan between the twin walls, and is heated by the heating element before passing around and/or in the chamber.

Typically, the incubator also includes electronic temperature control means, responsive to sensors in the chamber and/or on the infant's body. The temperature is monitored by the control means which then controls the heating element and/or fan to maintain the temperature at a desired level.

In order that the invention may be more fully understood and put into practice, preferred embodiments thereof will now be described.

#### BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is a perspective view of an incubator according to an embodiment of the invention;

Fig. 2 is a schematic sectional elevation of the incubator of Fig. 1; and

Fig. 3 is a schematic block diagram of the electrical control circuit of the incubator of Fig. 1.

#### DESCRIPTION OF PREFERRED EMBODIMENTS

As shown in the drawings, an infant incubator comprises a base 11 having a platform 12 thereabove on which an infant may be placed. Typically, the infant is

placed on a thin mattress, blanket or similar cushioning layer on the platform.

The base 11 is covered by a transparent canopy 13, which preferably is double-walled. The platform 12 and canopy 13 define a substantially closed environment for the infant. Access openings 18 may be provided in the canopy 13, or the canopy may be hinged to the base 11 and opened to allow access for nursing care and other therapeutic or diagnostic treatment.

10 A flat or planar heating element 14 is provided in the base 11 and located under the platform 12. The heating element is typically in the form of a flat membrane and comprises a planar electrically resistive element which on application of suitable voltage, will  
15 provide warming by ohmic heating.

In one embodiment, the flat heating element comprises a carbon layer encased or sandwiched in electrically insulating plastics sheeting.

A fan 15 is provided in the base to pass air  
20 over the heating element 14. The warmed air then passes through outlet 16 into the chamber within the canopy 13. Air is drawn from the chamber to the fan 15 through outlet 19.

Humidifying means may be incorporated in the  
25 incubator. In the illustrated embodiment, the humidifying means comprises a damp layer, such as a thin sponge or absorbent pad 20, on the face of the heating element 14 in the airflow path. Capillary action keeps the sponge 20 moist with water fed from a reservoir 21 via a tube 22.

30 In this manner, the airflow is not only heated by the heating element but also humidified. The use of such humidifying means obviates the need for an additional heating source for humidification.

In use, temperature sensors (not shown) are  
35 placed within the chamber, preferably both on the infant and at selected locations within the chamber. An electronic control circuit and display 17 are provided on a printed circuit board mounted near the front of the base

11.

As shown in Fig. 3, the electrical control circuit includes a microprocessor 25 which is programmed to detect hazard states, such as overheating or under-temperature, or component failure. The microprocessor 25 is connected to the output of a two channel temperature sensor which senses air temperature within the chamber and the infant skin temperature. In response to the sensed temperatures, the microprocessor 25 controls the operation of the heater panel 14, via a triac switch 27. A thermostat 28 provides feedback information regarding the actual temperature. Preferably, the control circuit controls not only the heater temperature, but also the fan speed, to maintain the temperature uniformly in the chamber at the desired level. The temperature is shown on the display 17 at the front of the base.

Several light emitting diodes 29 are also provided at the front of the base 11, and controlled by the microprocessor 25, to indicate various operating modes and alarm conditions. For example, in the event that a sensor 30 detects failure of the fan 15, the microprocessor 25 makes appropriate adjustment to the operation of the heater panel 14, and activates an alarm LED 29. An audible alarm is also actuated in addition to the visual alarm.

The abovedescribed incubator has a number of advantages, including:

- The planar heating element 14 can be housed in a low base 11, thereby enabling a compact design for the incubator.
- The flat heating element 14 not only warms the air passing into the chamber, but also provides radiant/conductive heating of the underside of the platform 12. In this manner, the infant is heated from all sides.



- The broad area over which heat is produced provides uniform heating of the infant bed. Unlike known closed chamber incubators with heated air, the incubator of this invention precludes the build-up of local areas of intense heat. Such focal hot areas, or "hot spots", act as a fire risk, and also as an explosive risk in the presence of oxygen which is commonly used in such devices.
- The membrane heating element is electrically safe, robust and of economical manufacture.
- The heating and control unit is easily removed from the incubator base, permitting easy cleaning and sterilisation.
- The heating means may also be used for humidification, avoiding the need for separate heating means for humidifying the air.

The foregoing describes only one embodiment of the invention, and modifications which are obvious to those skilled in the art may be made thereto without departing from the scope of the invention.

In a further embodiment of the invention (not shown), a membrane heating element is located between the spaced walls forming the canopy 13. This membrane heating element may be a transparent film heat source such as the type described in U.S. patents nos. 5,119,467 and 5,285,519. Instead of providing predominantly radiant heating however, the membrane heat source within the double-walled canopy is used to provide convection heating. Namely, air is blown between the walls of the double-walled canopy 13 by the fan 15, and is heated by the heating film or membrane. The heated air may be used to heat the canopy directly, and the interior of the

chamber indirectly. Alternatively, the heated air may be passed into the chamber for convection heating of the infant.



## CLAIMS:

1. An incubator suitable for newborn infants and the like, comprising
  - a base,
  - 5 a canopy over the base defining a chamber between the canopy and the base,
  - a fan for producing an airflow into or around the chamber, and
  - heating means for heating the airflow,
  - 10 characterised in that the heating means comprises a generally planar heating element.
2. An incubator as claimed in claim 1, wherein the heating element is a membrane-type heating element.
3. An incubator as claimed in claim 1, wherein the
  - 15 heating means comprises an electrically resistive carbon layer interposed between electrically insulating layers.
4. An incubator as claimed in claim 1, further comprising a platform on top of the base on which an infant may be laid, in use.
- 20 5. An incubator as claimed in claim 4, wherein the heating element is located within the base, and under the platform.
6. An incubator as claimed in claim 1, wherein the fan is located within the base, and blows air over the
  - 25 heating element and into the chamber through an opening in the top of the base, the air being recirculated from the chamber to the fan through another opening in the top of the base.
7. An incubator as claimed in claim 1, further
  - 30 comprising humidifying means for humidifying the airflow into the chamber.
8. An incubator as claimed in claim 7, wherein the humidifying means comprises a water retaining material placed in the airflow and in heat exchange relationship
  - 35 with the heating means.
9. An incubator as claimed in claim 1, further comprising at least one temperature sensor located within the chamber, an electrical control circuit connected to

the output of the temperature sensor(s), the control circuit being connected to the heating means and/or fan for controlling the temperature in the chamber in response to the output of the temperature sensor(s).

5 10. An incubator as claimed in claim 9, further comprising alarm means connected to the control circuit.

11. An incubator as claimed in claim 9, further comprising a display panel at the front of the base, the display panel being connected to the control circuit.

10 12. An incubator as claimed in claim 1, wherein the canopy comprises an interior wall and an exterior wall in close proximity thereto, the heating means being located in an air space between the interior wall and the exterior wall, and the airflow passes between the interior and  
15 exterior walls of the canopy before passing into the chamber.

13. An incubator as claimed in claim 1, wherein the base has a short vertical dimension relative to the canopy.

20 14. An incubator suitable for newborn infants and the like, comprising

a base having a platform thereon for supporting an infant,

a canopy over the base forming a chamber  
25 containing the platform,

fan means in the base for creating an airflow into the chamber, and

a distributed heating element located in the airflow in the base under the platform.

30 15. An incubator suitable for newborn infants and the like, comprising

a base having a platform thereon for supporting an infant,

a canopy over the base forming a chamber  
35 containing the platform,

fan means in the base for creating an airflow into the chamber,

a distributed heating element located in the

airflow in the base under the platform,

a heating element located in the airflow in the  
base under the platform, and

a water retaining layer of material in the  
5 airflow and in heat exchange relationship with the heating  
element.

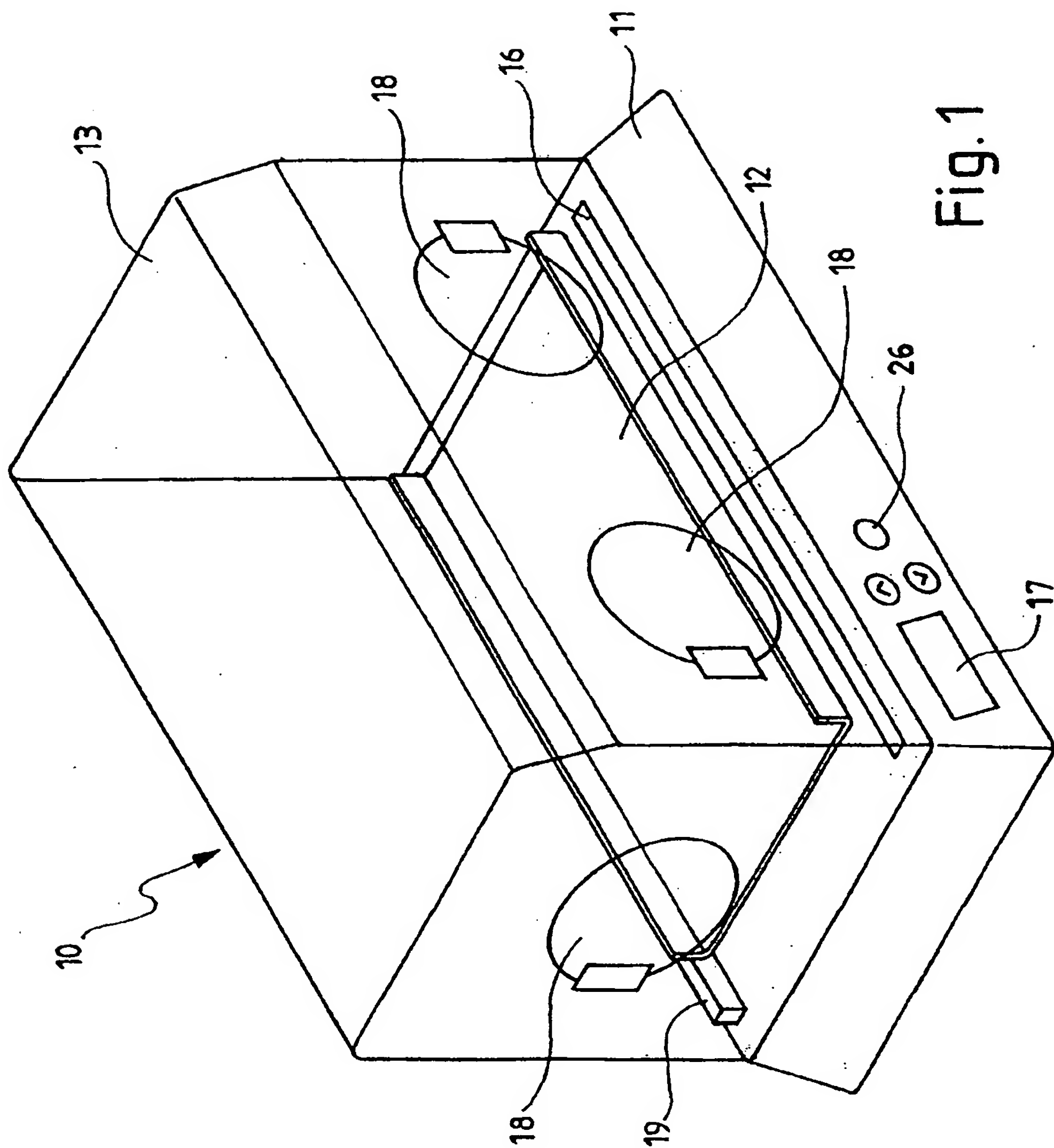


Fig. 1

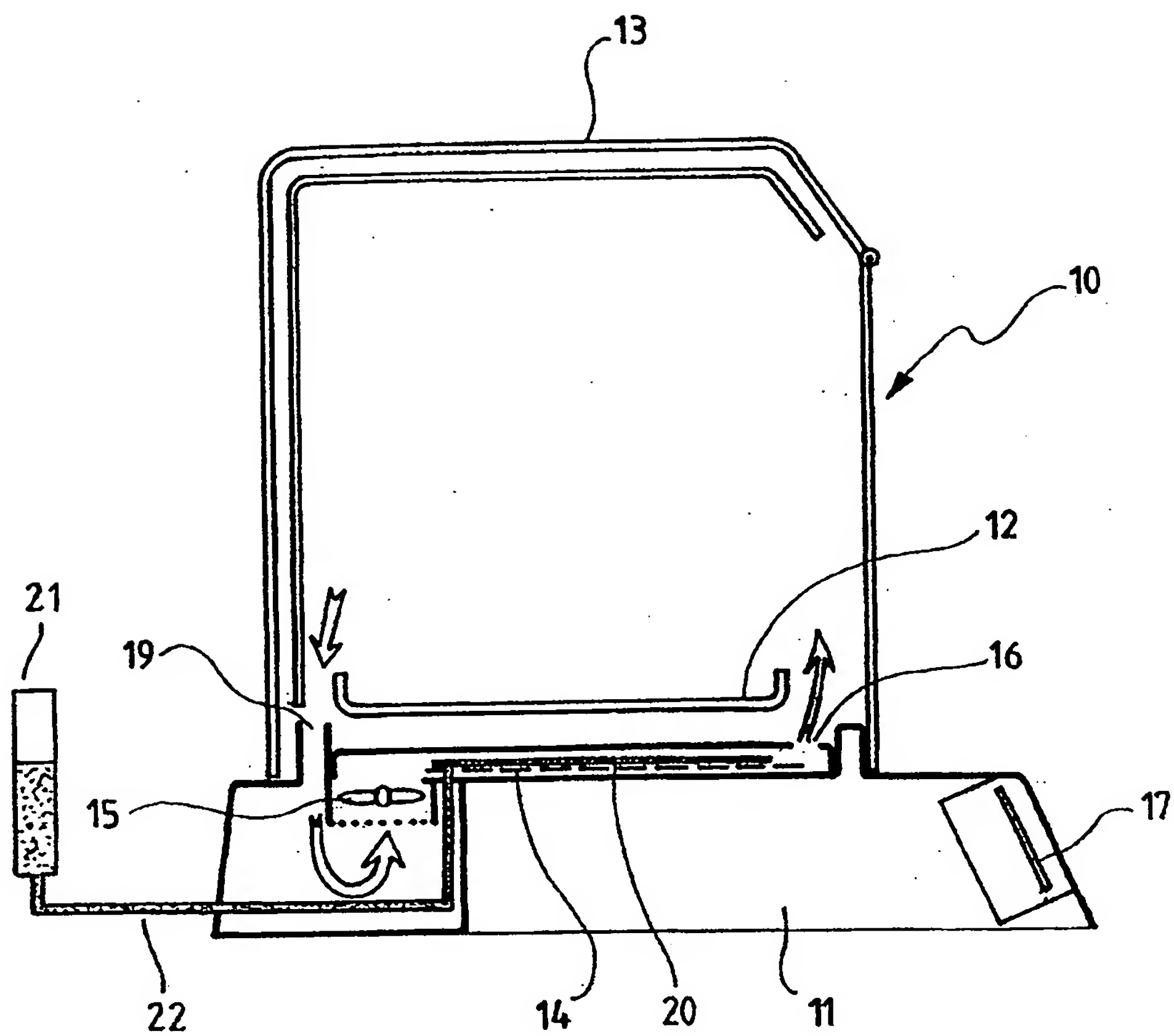


Fig. 2

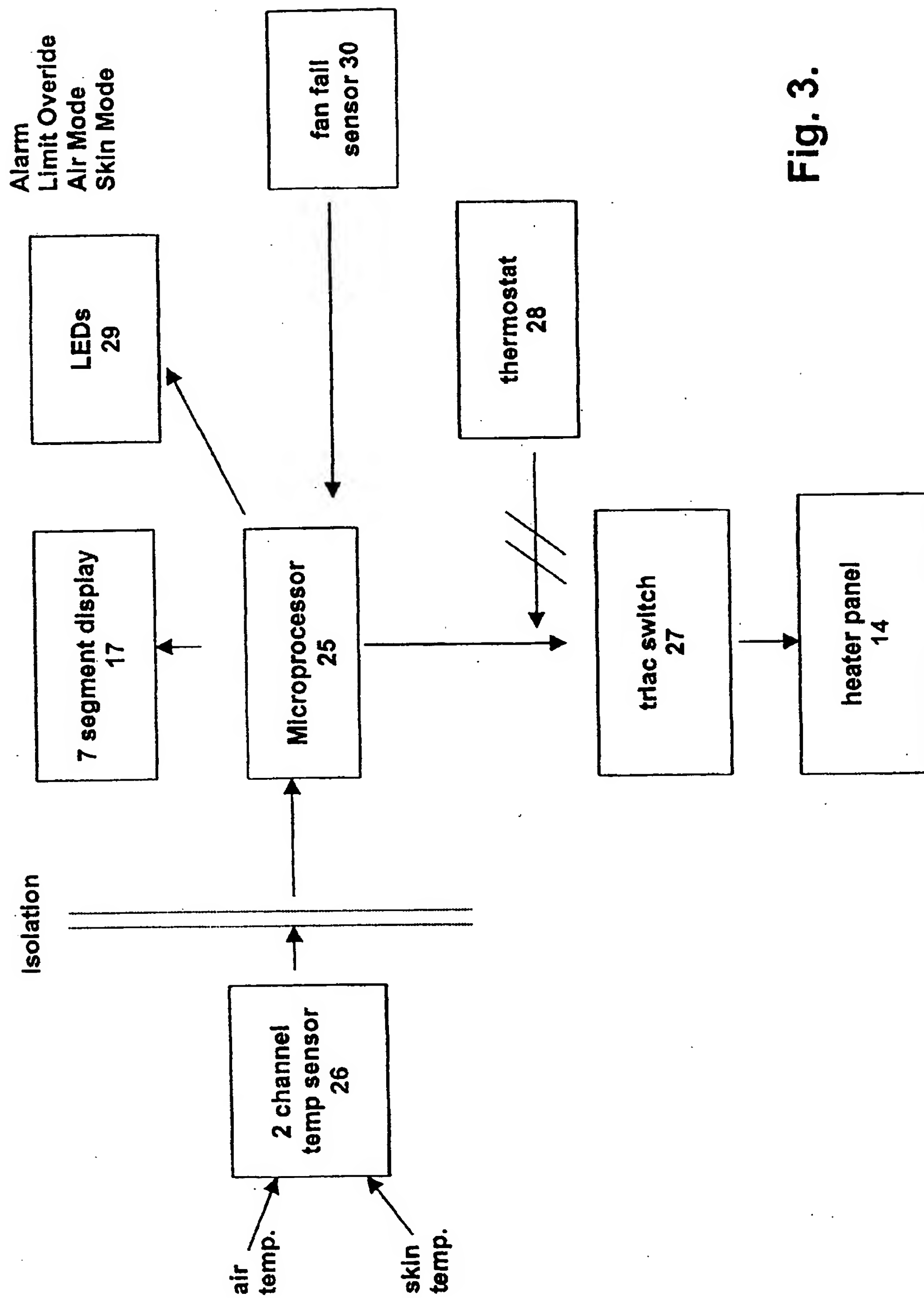


Fig. 3.

## INTERNATIONAL SEARCH REPORT

 International Application No.  
 PCT/AU 98/00294

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
Int Cl <sup>6</sup> : A61G 11/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols) IPC A61G 11/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched AU: IPC as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) WPAT JAPIO		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 3 919 999 A (GLUCK et al.) 18 November 1975 column 3 line 61 - column 4 line 4	1-5, 7, 9-11, 13, 14 6, 8-11, 15
X Y	Derwent Abstract Accession No. 94-200792/25, Class P33, CA 2079947 A (BEN-SIMHON) 7 April 1994	1-5, 7, 9-11, 13, 14 6, 8-11, 15
X Y	US 4 796 605 A (SASAKI et al.) 10 January 1989 figure 2 column 3 lines 55-60, column 6 line 65 - column 7 line 6	14, 15 6, 8, 15
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 16 June 1998		Date of mailing of the international search report 26 JUN 1998
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (02) 6285 3929		Authorized officer  DAVID MELHUISE Telephone No.: (02) 6283 2426



## INTERNATIONAL SEARCH REPORT

International Application No.

PCT/AU 98/00294

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	EP 687 458 A (OHMEDA INC.) 20 December 1995 column 4 lines 26-36 column 3 lines 50-54	14 6, 12
X Y	US 5 385 529 A (KOCH) 31 January 1995 figures 1 and 2 column 2 lines 37-45	14 9-11
Y	WO 92/03025 A (AIR SHIELDS, INC.) 20 February 1992 page 10 lines 6-25	12
A	DE 4 121 087 A (ELDECO ELEKTRONIK) 14 January 1993 figure 1	1

# INTERNATIONAL SEARCH REPORT

## Information on patent family members

**International Application No.**  
**PCT/AU 98/00294**

**This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.**

Patent Document Cited in Search Report				Patent Family Member			
US	4796605	JP	63019144				
EP	687458	CA	2148212	JP	8000679	US	5539854
US	5385529	DE	4103801	JP	5184630		
WO	9203025	EP	575325	MX	9100482	US	5119467
		ZA	9105803	US	5285519		

END OF ANNEX